

# Naval Surface Warfare Center Carderock Division

West Bethesda, MD 20817-5700



**NSWCCD-CISD-2006/008** May 2007

Ship Systems Integration & Design Department

Technical Report

## Uses of Commercially Chartered Heavy lift Ship for Auxiliary Naval Operations: A Summary Report

by

Robert Cullen



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1. REPORT DATE (DD-MM-YYYY) 28-Jul-2006		2. REPORT TYPE Final		3. DATES COVERED (From - To) 1-Jan-2007 - 11-May-2007	
4. TITLE AND SUBTITLE Uses of Commercially Chartered Heavy Lift Ship for Auxiliary Naval Operations: A Summary Report			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Robert Cullen			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES) Naval Surface Warfare Center Carderock Division 9500 Macarthur Boulevard West Bethesda, MD 20817-5700			8. PERFORMING ORGANIZATION REPORT NUMBER  NSWCCD-CISD-2006/008		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Office of Naval Research 875 North Randolph Street Arlington, VA 22203-1995			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION / AVAILABILITY STATEMENT Unrestricted Distribution					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The purpose of this report is to summarize the work conducted to explore the feasibility of using commercial chartered heavy lift ships for auxiliary naval operations. The premise is that the Navy cannot afford a series of unique classes of ship to provide all the required auxiliary naval operations. Therefore, the concepts developed in this study focused on methods of using existing technology and systems as modular platforms that will act in conjunction with a commercial chartered heavy lift ship. This study focuses on three specific concepts that involve using a heavy lift ship to serve as either a maintenance and repair ship, a mobile casualty receiving ship or a disaster relief ship. Each concept is presented with a space analysis and a 3-D CAD model. Sea keeping is not assessed as part of this study.					
15. SUBJECT TERMS Heavy Lift Ship, Auxiliary Naval Operations, Disaster Relief, Maintenance, Repair, Casualty Receiving					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT  None	18. NUMBER OF PAGES  28	19a. NAME OF RESPONSIBLE PERSON Jeffrey J. Hough
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code) 301-227-5670



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## **Abstract**

*The purpose of this report is to summarize the work conducted to explore the feasibility of using commercial chartered heavy lift ships for auxiliary naval operations. The premise is that the Navy cannot afford a series of unique classes of ship to provide all the required auxiliary naval operations. Therefore, the concepts developed in this study focused on methods of using existing technology and systems as modular platforms that will act in conjunction with a commercial chartered heavy lift ship. This study focuses on three specific concepts that involve using a heavy lift ship to serve as either a maintenance and repair ship, a mobile casualty receiving ship or a disaster relief ship. Each concept is presented with a space analysis and a 3-D CAD model. Sea keeping is not assessed as part of this study.*

## **Acknowledgments**

This report is a summary of the work completed by David Jurkiewicz, Jennifer Gardner, and Robert Cullen. The author would like to thank David Jurkiewicz and Jennifer Gardner for their contributions and Dr. Christopher Dicks and Dr. Colen Kennel for their assistance in compiling this report.

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## **Introduction**

### **Objective**

The purpose of this study is to explore the feasibility of using of commercially available heavy lift vessels for auxiliary naval operations. The goal is to use commercially chartered heavy lift vessels to transport material and equipment to perform a specific function instead of building a ship dedicated to that specific function. The concepts generated in this study are designed to satisfy three core design requirements:

- use existing technology and capabilities;
- minimize the number of modifications required to the heavy lift vessel. (All modifications must be reversible); and
- remain adaptable to a variety of situations and requirements.

Based on these three core design requirements, three specific applications for the use of heavy lift vessels in marine support roles were researched and developed. These applications were:

1. a marine maintenance and repair platform;
2. a modular casualty receiving ship; and
3. a disaster relief ship.

Each of these designs was created using existing military and commercial technology and capabilities. All the systems required for the concepts were also designed to operate in conjunction with ISO containers wherever possible. In order to ensure that the system designs could be supported by a variety of commercially available heavy lift vessels, an analysis of space and weight considerations was conducted for each design and compared with the space and weight capacities of three representative commercially available heavy lift vessels. Also, 3D models of each design were created to display the layout of the systems on these representative heavy lift vessels. A sea keeping analysis of the designs was not performed and should be taken into account when assessing the feasibility of each design.

### **Background**

Heavy lift vessels have been used in the marine industry to perform a variety of functions ranging from transporting large oil platforms to transporting damaged ships. The US Navy has explored the use of heavy lift vessels for several applications in recent years including their use as ship transports as well as components in sea basing exercises. These vessels have many advantageous characteristics that suit them for mission support operations. The advantages include:

- Large deck space
- Large load capacity
- Storage tanks for POL, fresh or salt water
- Capability to ballast/de-ballast to load/offload cargo
- Sea walls
- Not restricted to one type of cargo
- Large capacity cranes



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These advantages represent those offered by a variety of commercially available heavy lift vessels and no single vessel has all of the advantages listed above. As a result, there is a tradeoff between different heavy lift vessels based on what functions and characteristics are required for the specific marine operation. For example, if the specific operation requires transportation of a large, heavy structure such as the spar buoy seen in Figure 1, then a heavy lift vessel with an open deck area and large weight capacity would be required. However, if the specific operation requires a dry dock for ship repairs or a personnel staging area that requires shelter from the weather, then a heavy lift vessel with wind walls similar to Figure 2 would be required.



**Figure 1: Dockwise heavy lift vessel M.V. Black Marlin transporting a spar buoy ([www.dockwise.com](http://www.dockwise.com)).**



**Figure 2: Dockwise heavy lift vessel Explorer transporting yachts ([www.dockwise.com](http://www.dockwise.com)).**

## **The General Concept**

The concepts for using heavy lift ships for auxiliary naval operations begin by chartering a commercially available heavy lift ship. The ability to charter a commercially available heavy lift ship is essential to the concepts because it is this ability that allows the Navy to perform these operations without building a dedicated ship. Once a heavy lift ship is chartered, it will travel to the homeport where the auxiliary systems required for the specific operations are stored. These supplies would be loaded onto the heavy lift ship using either dock side cranes or Mobile Causeway Sections, and any adjustments that need to be made to the heavy lift ship will be made. Once these preparations are complete, the heavy lift vessel will travel to the operation area and perform its mission. Once the mission is complete, the heavy lift vessel will return to the home port, the operation systems will be offloaded and stored for future use, any modifications made to the vessel will be repaired, and the heavy lift vessel will return to the commercial shipping industry.

## **General Requirements**

The concepts generated in this study are designed to satisfy three core design requirements:

- The design must use existing technology and capabilities
- The design must require as little modification of the heavy lift vessel as possible
- The design must be adaptable to a variety of situations and requirements

Based on these requirements, the concepts are also required to provide general services and capabilities for each application of a heavy lift vessel as a mission support platform, regardless of the type of operation. These general requirements include:

- Accommodations and Hotel Services for Personnel
- Storage of supplies and spare equipment
- Provision of services
  - Electrical power
  - High/low pressure air
  - Distilled water
  - Waste treatment/storage
- Provision of infrastructure
  - Communications
  - Transportation of personnel
    - Boats
    - Helicopters
    - Crane capability

In addition to these general requirements, each of the three applications of a heavy lift ship as a mission support platform discussed in this study require case specific capabilities and functions. These specific requirements include:

### **Maintenance and Repair Vessel (MAR)**

- Ability to safely position MAR capability relative to stricken vessel
- Provision of workshops and material
- Provision of Waste Management
- Ability to conform to Maritime Pollution and other anti-pollution regulations
- Ability to carry out structural repair of steel and composite vessels
- Ability to repair combat systems
- Ability to repair sensors and communications equipment
- Ability to conduct underwater MAR operations
- Provision of fire-fighting assistance to stricken vessels
- Ability to handle hazardous materials
- Ability to support conduct salvage operations
- Provision of dry-dock for ships smaller than 150 m in length

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**Modular Casualty Receiving Ship (MCRS)**

- Ability to accommodate medical casualties
- Provision of stowage for core medical equipment supplies
- Provision of medical and surgical equipment
- Ability to receive general medical stores
- Provision of reception areas, wards, operating theatres, x-ray wards, support and staff facilities and ready use stores for medical applications
- Provision of methods of recovering wounded and injured personnel from helicopters and landing craft
- Internal transfer of personnel to medical facilities

**Disaster Relief**

- Provision of workshop and material to support disaster relief on shore
- Ability to transport personnel, stores, and equipment to and from the disaster affected area
- Ability to conduct disaster relief and support humanitarian action by other parties
- Provide emergency medical hospital facilities
- Deliver disaster relief capacity during a medical epidemic

Another set of requirements involves the space and weight requirements of the heavy lift vessels that will be used as mission support platforms. Three representative vessel types were chosen to use as a basis for system designs including:

- Large load capacity, open deck (similar to M.V. Black Marlin)
- Combination product tanker and heavy lift vessel (similar to M. V. Explorer)
- Specialist dock or yacht transport ship (similar to CombiDock 1 & 2)

The rationale behind choosing three different types of heavy lift vessels to use as a design basis is that the concepts should be able to work with a variety of heavy lift vessels and should not be designed for a specific vessel. This design requirement will allow the concepts to work with a variety of heavy lift vessels and not be limited if specific vessels are not available. The general characteristics of the three representative heavy lift vessels can be found below in Table 1. Schematics of the heavy lift vessels as well as additional vessel characteristics can be found in Appendixes B, C, and D.

**Table 1: Indicative Heavy lift vessels and characteristics.**

Ship	Length of Storage (m)	Width of storage (m)	Deck Area (m <sup>2</sup> )	Weight Capacity (MT)	Defining Characteristic
M.V. Black Marlin	178.2	42.0	7484.4	205,821	Large open deck surface
M.V. Explorer	117.4	25.2	2822.8	42,342	Sea Walls
CombiDock	132.6	18.9	2506.2	53,888	Several-hundred ton capacity cranes

## General System Attributes

In order to satisfy the three core design requirements discussed in Section 1.3, there are two key components that form the basis of each of the heavy lift vessel concepts. These two components are reconfigured 20 ft ISO containers and Mobile Causeway Sections (MCS). The use of these components allows the heavy lift concepts to be adaptable to different operations and also limits the amount of modifications that need to be made to the heavy lift vessel. The following sections briefly describe the use of these two components in order to provide mission support operations using a heavy lift vessel.

### 20 ft ISO Containers

The use of 20 ft ISO containers within the heavy lift concepts is essential because they provide adaptability to different missions and operations. These containers can be designed for any number of different configurations and provide many different capabilities. For example, there are specially configured, commercially available containers that provide housing, shower, and bathroom accommodations for personnel. An example of an ISO container converted for use as personnel housing can be seen below in Figure 3 and Figure 4. There are also containers available that are built to store water treatment processors, act as workshop areas, or act as command centers. The containers can either be connected directly to the deck of the heavy lift vessel or to mobile causeway sections during transport to the specific operation using ISO cargo locking systems.

Another advantage of using ISO storage containers within the heavy lift concepts is that they can be easily stored and transported when they are not deployed. The containers can be stored at a port when not in use, and when the time arises that they are needed, they can be loaded directly on to the heavy lift ship using dockside cranes. This storage capability also saves time in preparation for the support mission because the containers can be configured and prepared while the heavy lift vessel is in transit to the homeport. Once the heavy lift vessel arrives, the containers can be immediately loaded onto the deck and the heavy lift vessel can proceed to its operating area.



Figure 3: Outside view of shipping container configured for housing ([www.energistx.com](http://www.energistx.com))



Figure 4: Interior view of shipping container configured for housing ([www.energistx.com](http://www.energistx.com))

## Mobile Causeway Sections

The mobile causeway system (MCS) consists of several Intermediate Modular Causeway Sections (IMCS). These sections are 80 ft long, 24 ft wide, have a depth of 4-6 ft and weight approximately 66 MT. Each MCS section is designed to support the weight of a 60 MT Abrams tank and can be stored inside a standard 40 ft ISO container. The MCS sections would be used as platforms to place the components and ISO containers necessary to carry out the different marine support missions. The concept is to assemble the MCS sections to the required size and arrange the necessary components at a port while a heavy lift ship is being secured. Once the heavy lift ship arrives, the MCS sections will already be assembled and can be loaded and moored onto the heavy lift ship for transport to the desired area. Once at the desired area, the MCS sections can remain on the heavy lift ship during the operation, or they can be offloaded to allow the heavy lift ship to fulfill other roles. An example of these MCS sections can be seen below in Figure 5.

One advantage of using MCS sections as a platform for marine support missions is that they can operate independently of the heavy lift vessel. For example, if the heavy lift vessel cannot remain with the MCS sections while the marine support operations are underway, the vessel can offload the MCS sections, then return later to bring the sections back to storage. However, a disadvantage of using the MCS sections is that they can only operate in lower sea states and benign weather when operating independently of the heavy lift vessel. Another advantage is that placing equipment directly on the MCS sections instead of directly on the heavy lift ship requires less modification of the heavy lift ship deck. This characteristic of the concept is an advantage because any modifications performed on the heavy lift vessel must be removed/repaired at the end of the operation. Because the MCS sections can be assembled while the heavy lift vessel is in transport, time that would have been used to assemble the marine support equipment when the heavy lift vessel arrived can now be used to perform the support mission itself.



Figure 5: MCS sections arranged into a large working area.

## **Applications**

In order to demonstrate the feasibility of using commercially available heavy lift vessels for auxiliary naval operations, concepts were generated and studied for three specific applications. These applications include the following:

1. Maintenance and Repair Vessel (MAR)
2. Mobile Casualty Receiving Ship (MCRS)
3. Disaster Relief

However, these are not the only applications of using a commercially available heavy lift vessel. Other applications include, but are not limited to the following:

- Land Force Engineering Maintenance and Repair Ships
- Boat Transport Ships
- Seabase Support Ships

Each of the three specific concepts discussed in this report was designed to operate in conjunction with the three heavy lift ships described in Section 1.3. The following paragraphs provide a summary of each concept as well as an example of how the concept could be deployed in conjunction with a heavy lift vessel.

### **Maintenance and Repair Vessel (MAR)**

#### **Summary**

The purpose of this concept is to provide the capability of marine maintenance and repair (MAR) without building a ship dedicated solely to this task. The idea is to use heavy lift ships as staging platforms for modular MAR units, which would consist of ISO containers connected to Mobile Causeway Sections. The concept focuses on providing the capability to perform several different MAR capabilities while being able to work in conjunction with a variety of different heavy lift vessels.

Several resources were used in order to establish the capabilities that a MAR system should be able to provide including research into land based repair facilities, current Navy MAR vessels, current on-board repair capabilities of U. S. Navy ships, and consultations with CISC personnel. This research resulted in the following capabilities that an MAR system should be able to perform:

Air compressor repair	Hose repair	Rigging repair
Air conditioning and refrigeration repair	Heat exchanger, cooler and distilling plant repair	Sheet metal repair
Valve repair	Hydraulic systems repair	Structural repair
Boiler repair	Machinery shaft alignment	Diesel engine repair
Cam pump repair	Oxygen –nitrogen producer repair	Electric motor repair
Centrifugal pump repair		Electrical equipment repair
		EPA refrigerant handling

In order to provide these capabilities, as well as satisfy the general requirements, there will be several different standard ISO containers. A few examples of these standard ISO containers include housing containers, machine shop containers, communication containers, storage containers, and power generation containers. A sample layout and detailed list of the different containers is located below in Figure 6. The specific



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containers as well as the layout of the containers will vary depending on the specific MAR mission.



**Figure 6: List and top down view of the different areas designated to provide MAR capabilities.**

**Example**

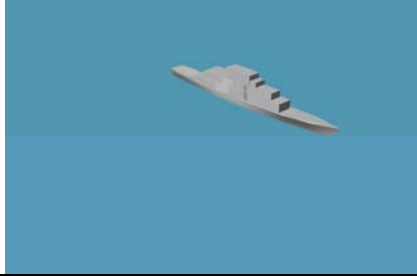
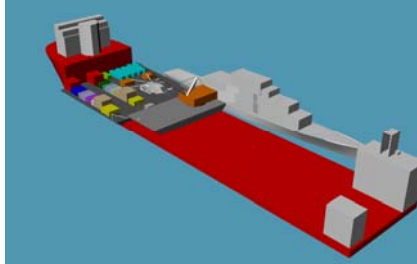

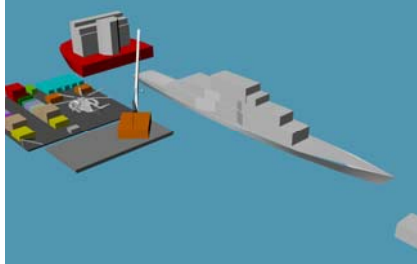
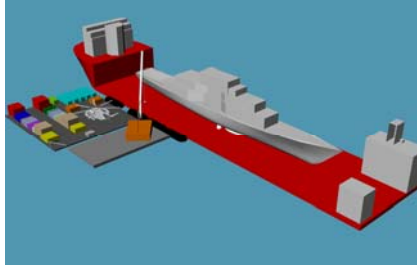
There are three main situations utilizing a heavy lift vessel as a MAR platform. The first situation involves assisting a damaged vessel by mooring the heavy lift vessel to the damaged ship while the MAR platform is on the heavy lift vessel deck. This situation would occur when the damage to the ship does not require dry docking to repair. CISD personnel studied the feasibility of mooring a ship to a heavy lift ship in 2005 (Figure 7).



**Figure 7: M.V. Black Marlin moored to USNS Watkins during seabasing operation.**


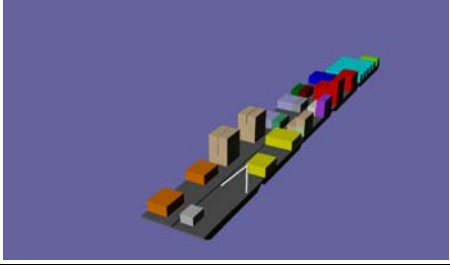
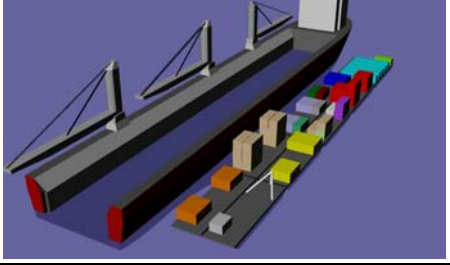
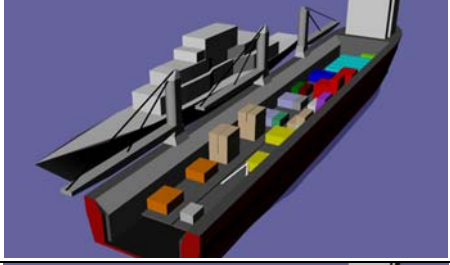

If dry docking is necessary to perform repairs, there are two additional situations that can occur. The first involves dry docking a smaller ship on the heavy lift vessel while the MAR system remains on the heavy lift vessel. The second situation involves offloading the MAR system from the heavy lift vessel, dry docking a ship, and mooring the MAR system to the heavy lift ship. The advantage of the MAR system remaining on the heavy lift vessel during repair is increased stability of the system. However, removing the MAR system from the heavy lift vessel allows the heavy lift vessel to perform other activities. The following is a list of the steps involved in performing the three different MAR operation cases.

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<i><b>M.V. Black Marlin</b></i>	<i><b>Description</b></i>
	When a naval ship is damaged, the ship will report the incident to the Naval command. In response, the Navy will charter a heavy lift vessel to transport the MAR system from storage at its homeport to the operation area.
	Once the MAR components are loaded onto the heavy lift vessel, the vessel will travel to the operation area. The heavy lift vessel will position itself alongside the damaged ship to begin the MAR operation. If dry docking is not required, the heavy lift vessel will be moored to the ship and the MAR operation will begin.
	If dry docking is required, the heavy lift vessel will submerge in order to offload the MAR system. Once the MAR system is offloaded, the heavy lift ship will deballast so the deck can be prepared for the dry-docking portion of the mission.
	Once the preparations are complete for dry-docking, the heavy lift ship will ballast down and position itself underneath the damaged ship.
	Once the heavy lift vessel is in position underneath the damaged ship, the heavy lift ship will deballast, completing the dry-docking portion of the mission. After this step is complete, the MAR platform will be moored to the side of the heavy lift vessel and begin MAR operations.



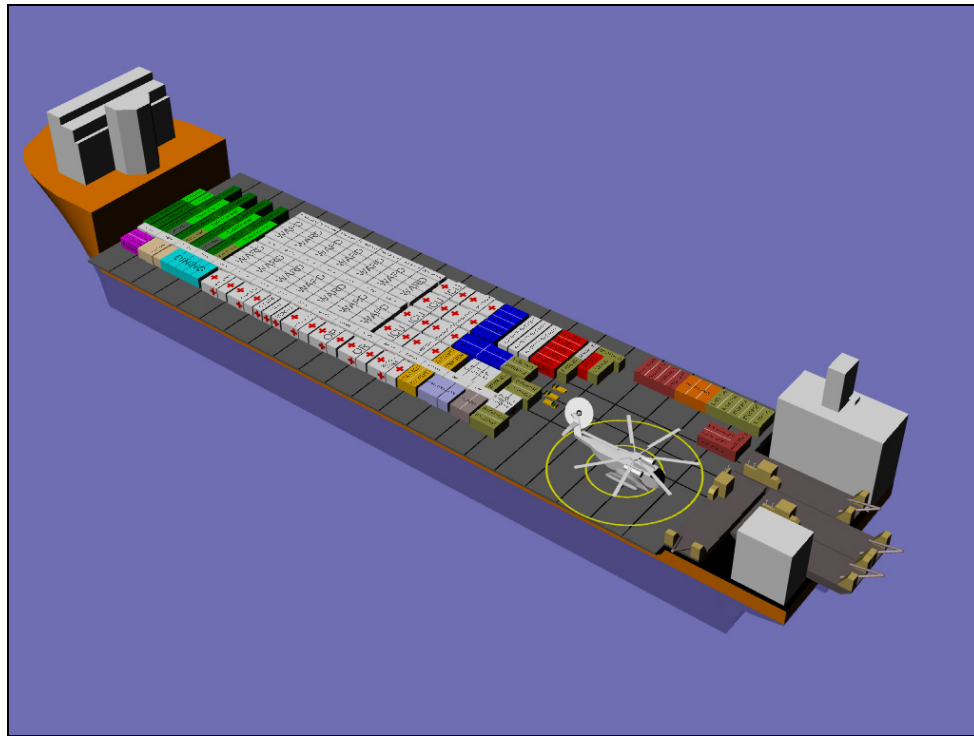
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<i><b>CombiDock</b></i>	<i><b>Description</b></i>
	When a naval ship is damaged, the ship will report the incident to the Naval command. In response, the Navy will secure the use of a heavy lift vessel to transport the MAR system from storage at a port to the damaged ship.
	The MAR platform will be assembled in its homeport while the heavy lift vessel is in transit.
	Once the heavy lift vessel arrives, it will ballast down, load the MAR platform, and then deballast. Once the MAR platform is loaded, the heavy lift ship will proceed to the operation area.
	Once the heavy lift vessel arrives, it will be moored to the damaged ship and the MAR operation will begin.
	The CombiDock will use its onboard cranes to transfer material to and from the damaged ship. Once the operation is complete, the heavy lift vessel will return to the homeport, offload the MAR platform, and return to functioning as a commercial heavy lift ship.

## Modular Casualty Receiving Ship (MCRS)

### Summary

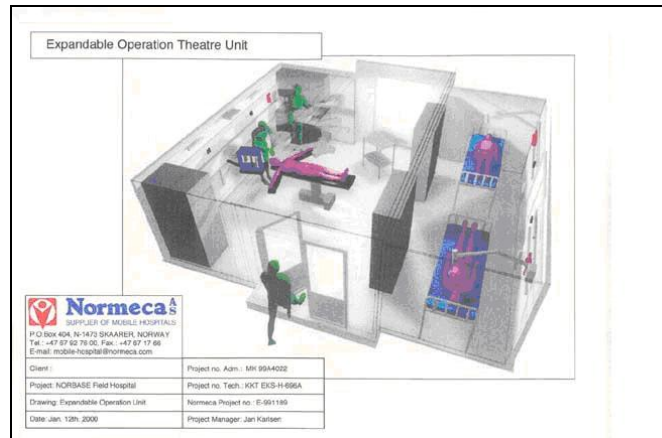
The purpose of this concept is to explore the use of commercially available heavy lift ships as modular casualty receiving ships (MCRS). The concept revolves around a standard field hospital (FH) being constructed, or floated, onto the deck of a commercially available heavy lift ship for rapid deployment. Doing so eliminates the need for the U.S. Navy to construct or purchase a heavy lift ship, but rather lease any commercially available heavy lift ship for a relatively short period of time. The goal is to be able to support the maximum amount of patients for the maximum amount of time with as little re-supply as possible. Figure 8 shows a representation of the MCRS.



**Figure 8: Representation of a heavy lift ship as the basis for a MCRS.**

The general concept involves housing the medical facilities and support facilities that make up a standard FH in shipping containers. These containers would either be built directly on the deck of the heavy lift ship, or floated onto the heavy lift ship using Mobile Causeway Sections. Once assembled, the FH would also have containers that act as corridors between the different medical facilities. The use of shipping containers in the concept insures that the medical facilities are completely enclosed and are sheltered from the environment. The use of the corridors insures that when a patient is transferred from one facility to another, they will also be shielded from the environment. A sample configuration of a shipping container as a medical facility can be seen below in Figure 9.

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**Figure 9: Theoretical arrangement of a medical facility within a shipping container.**

The configuration of the hospital used in this study is based on a standard army FH found in the FM 8-10-155 report. This type of hospital can be mobilized relatively quickly to provide adequate medical care to soldiers in the field. Based on information presented by a combination of various FH manufacturers and in the FM 8-10-15 report, the FH has several options for different medical facilities that can be included for different missions. The options evaluated include the following:

Blood bank	Intensive Care Unit (ICU)	Sterilization
CT/MRI Scanner	Laboratory	Operating room (OR)
Dental	Patient Wards (WARDS)	X-Ray
Emergency triage	Pharmacy	

The medical facility options listed above are essential to any FH and will appear in the design. In order to support and maintain the medical facility several support options, they must work in conjunction with support facilities to maintain and operate it. These facilities include:

Accommodations (Personnel)	Helicopter pad	Oxygen Storage
Administrators	Kitchen	Patient Process Center
Communications	Laundry	Power Generation
Dining/Recreation	Medical/Mechanical	Shower/Toilets
Fuel Storage	Maintenance	Solid Waste Storage
Food Storage	Medical/Miscellaneous Storage	Water Treatment/Storage

In order to calculate the number of patients that the MCRS could support, several factors were considered including:

- Information from FH manufacturers and the FM 8-10-15 report
  - Amount of specific supplies necessary/patient
  - Amount of support personnel/patient
- Number of days of operation
- The deck space available on the heavy lift ship

The calculations began by using in the information from the FH manufacturers and the FM 8-10-15 report to establish the amount of supplies and support personnel that would be required per patient for ten days. The difficult part of calculating the number of

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patients the MCRS could support came in adapting the numbers established using the reports in to the available deck space on the heavy lift ships. The information provided by manufacturers and the FM 8-10-15 report is based on a land based FH, and the difference between land and sea based FHs is the amount of area available for use. Land based FHs have much more area to utilize, while a heavy lift ship based FH is limited by the amount of deck space. In order to account for this space factor, models of the different medical facilities and heavy lift ships were developed using Rhinoceros®. Using these models, the medical facilities and required support material were arranged on the decks of each heavy lift vessel. Several iterations were performed to find the optimum number of patients that each heavy lift ship could support for ten days. The results of these iterations can be found below in Table 2.

**Table 2: Number of patients and personnel that a heavy lift ship can support.**

<b>Vessel</b>	<b>Patients</b>	<b>Personnel</b>	<b>Total</b>
<i>M.V. Black Marlin</i>	216	185	401
<i>CombiDock</i>	60	52	112
<i>M.V. Explorer</i>	96	83	179

As can be seen in Table 2, the M.V. Black Marlin has an advantage because it has the ability to support the largest number of patients and personnel, which results from the fact that it has the largest deck area. However, a disadvantage of the M.V. Black Marlin is that large open deck area subject to environmental conditions. The containers provide some protection, but using a ship with wind walls such as the CombiDock or M.V. Explorer would provide greater protection. Ultimately, there is a tradeoff between protection from the environment and the number of patients that can be accommodated.

**Example**

This section provides further detail into the use of the M.V. Black Marlin as the basis for a MCRS. The advantage of the M.V. Black Marlin is that it has a large open deck area, so it can support a larger number of people than the CombiDock and M.V. Explorer. A breakdown of the number of patients and medical personnel that can be supported by the M.V. Black Marlin is shown in Table 3.

**Table 3: Number of patients and medical personnel that can be supported using M.V. Black Marlin**

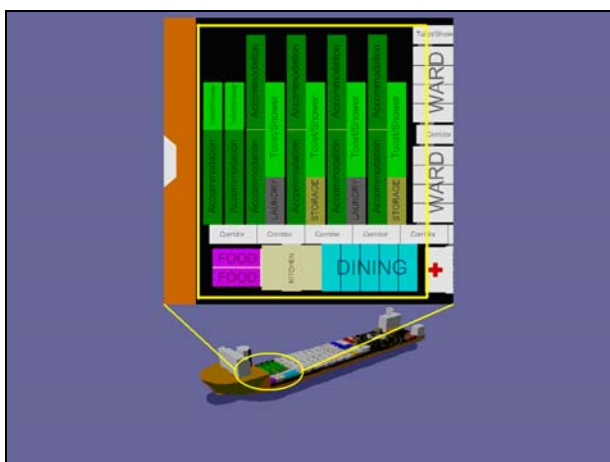
<b><i>Field Hospital Consumption (per day)</i></b>	<b><i>Input</i></b>
Number of Patients (Total)	216
Number of Surgical Cases	24
Number of Bed Patients (ICU)	24
Number of Minimal Care Patients	100
Number of Decontamination Cases	10
Number of Staff	185
Number of Days	10
Generator power output (Continuous kilowatts)	1125
Generator fuel consumption (gph)	104
Daily power requirement (kW)	599

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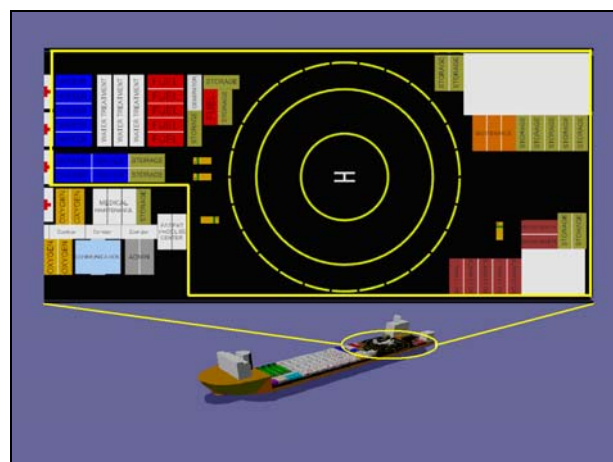
The facilities required to support a FH on a heavy lift ship were arranged according to function and flow. The ship will be organized into three separate areas:

1. Personnel housing and dining
2. Medical Facilities
3. Material storage and transportation

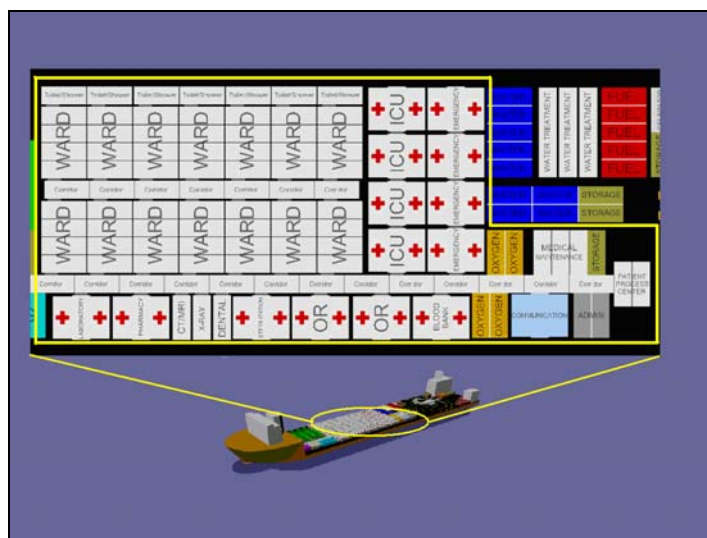
The medical facilities are centralized to provide the quickest access for medical personnel one on one side, and supplies and transportation on the other side. Locating the medical facilities in a single area means that they can all be interconnected using the container corridors. This action results in less time that the patient will spend on the unsheltered environment of the open deck. A representative arrangement of the three areas is shown in Figures 10 to 12.



**Figure 10: Personnel housing and dining**



**Figure 11: Material storage and transportation**

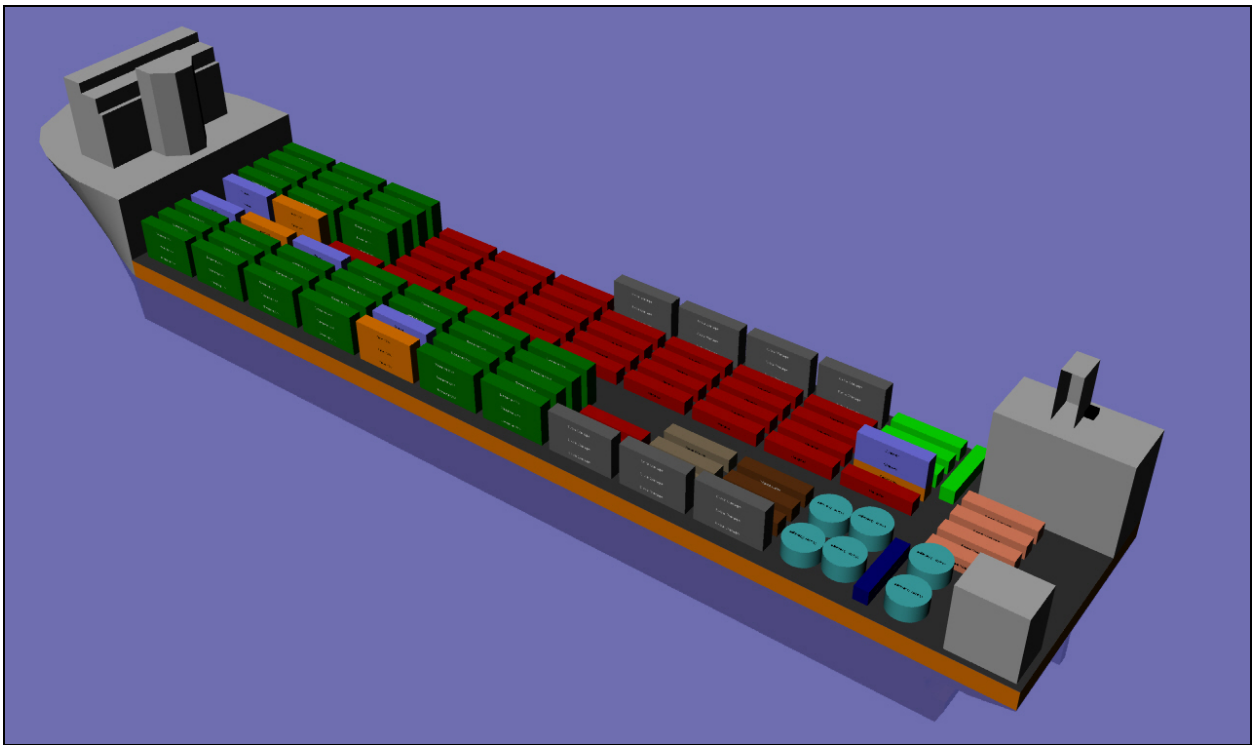


**Figure 12: Medical facilities**

## Disaster Relief Ship

### Summary

The purpose of this concept is to explore the use of a commercially available heavy lift ship as a platform for disaster relief operations. The concept involves placing the systems needed to support a disaster relief effort directly on the deck of a commercially available heavy lift ship. The goal is to be able to support the largest number of people possible for ten days while providing all of the necessary services. Similar to the other concepts, the design involves basing the required disaster relief facilities in ISO containers and storing them at a homeport until their use is required. Due to the modularity of the ISO container based designs, the number and type of each facility can be varied depending upon the specific requirements of the operation. Figure 13 shows an example of the use of an open deck heavy lift ship as a disaster relief ship.



**Figure 13: representation of an open deck heavy lift ship used for disaster relief operations**

When a disaster occurs, such as a hurricane or tsunami, a heavy lift ship will be chartered. The ship will travel to the port where the disaster relief systems are stored and these systems will be loaded onto the deck of the heavy lift ship. There are two options for loading the systems onto the heavy lift ship; directly attaching the ISO containers to the deck of the heavy lift ship, and attaching the ISO containers to Mobile Causeway Sections that can be floated onto and subsequently moored to the deck of the ship. The heavy lift ship would then transport the disaster relief systems to the disaster area to conduct relief operations.



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The services that the disaster relief ship can supply are designed to provide displaced individuals with all of the necessary amenities until they can return to their homes. The services that will be provided by the disaster relief ship include the following:

- Sleeping units
- Food and water
- Shower and toilet facilities
- Water treatment
- Medical facilities
- Storage
- Laundry services

A spreadsheet was developed in order to calculate the space and weight characteristics of the disaster relief facilities required for a specific amount of people. The spreadsheet takes an input of the number of people that need to be supported and then calculates if it is feasible for each of the three sample heavy lift ships to support this amount of people based on the facilities that would be required to support them. Three different cases are considered of how the containers are arranged on the deck for each type of heavy lift ship. The three cases include stacking the dining, sleeping, shower, and toilet containers one high, two high, or three high. Stacking the containers provides more room to accommodate a larger amount of people. However, the higher the containers are stacked, the more sea keeping becomes an issue, and sea keeping is not considered in this report. Based on the three different arrangements as well as the three different heavy lift ships, Table 4 shows the maximum amount of people that the disaster relief ship can support.

**Table 4: Estimated number of people that a disaster relief ship could support**

<i><b>Heavy Lift Ship</b></i>	<i><b>Estimated Number of People Supported</b></i>		
	<i><b>1 Level of Containers</b></i>	<i><b>2 Levels of Containers</b></i>	<i><b>3 Levels of Containers</b></i>
<i><b>M.V. Black Marlin</b></i>	1100	1620	1980
<i><b>M.V. Explorer</b></i>	360	560	660
<i><b>CombiDock</b></i>	220	360	420

**Note: The level of containers refers to how many sleeping, dining, shower, and toilet containers are stacked on top of each other on the deck.**

As can be seen from the table, the M.V. Black Marlin can support the largest amount of people when the disaster relief containers are stacked three high. However, as with the two other concepts, there is a tradeoff between the number of people that can be supported and protection from the environment. Although the M.V. Explorer and CombiDock heavy lift ships cannot support as many people as the M.V. Black Marlin, they have wind walls that shelter the deck from the environment. While the containers provide some shelter, they do not provide as much as can be provided by the wind walls. Ultimately, the decision to go with an open deck to accommodate a large number of people or to go with a wind walled ship to provide a sheltered environment will depend on the type of disaster that occurs.

### Example

The ship in this example is an open-deck heavy lift ship as seen above in Figure 13. The deck has been broken up into 107 sections; 103 longitudinal sections and 4 transverse sections. Each section is the size of one standard ISO container plus a walkway of 1.5 meters on the long side and 3 meters on the short side. The grey sections in Figure 14 represent the placement of ISO containers on the deck of the ship. The dark gray spaces in the figure represent walkways and areas that do not support placing a container (such as the wheel house). The walkways allow for people to move around between the different facilities, such as traveling from the sleeping area to the dining area. The disaster relief facilities are broken up into the following sections:

- Water
- Accommodations and hotel services
- Hospital facilities
- Waste treatment
- Supplies
- Dining

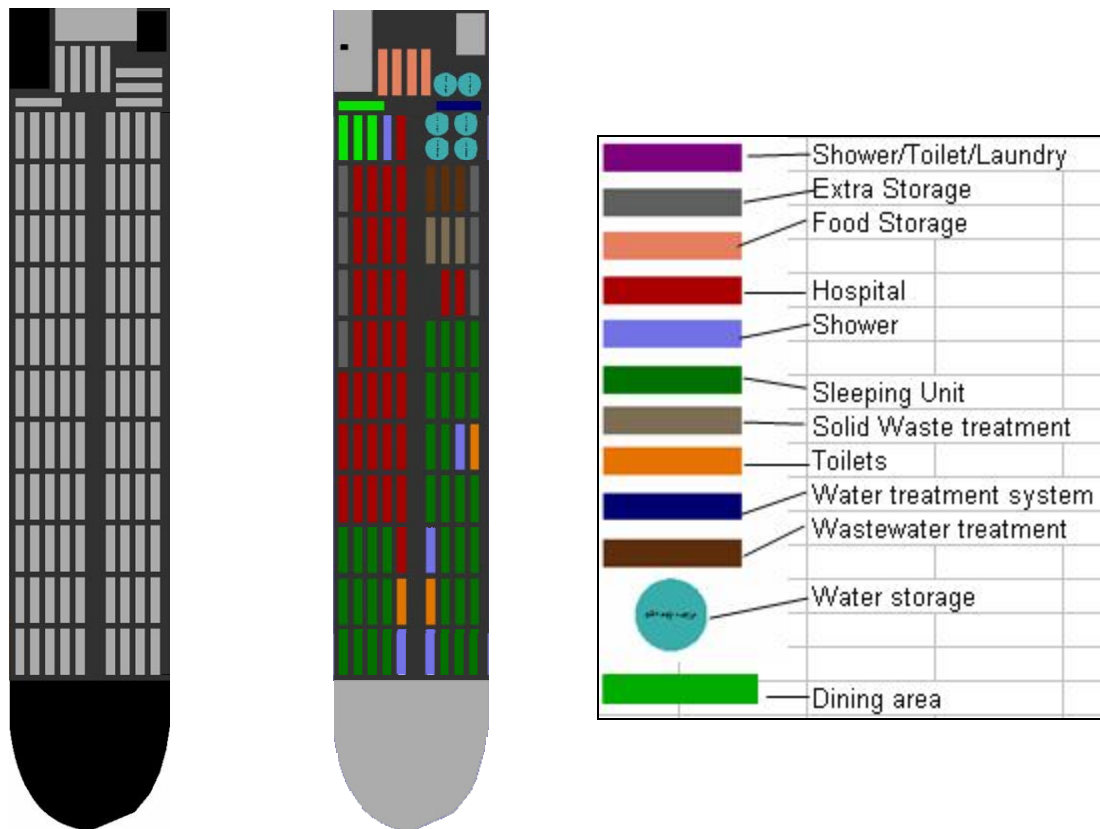


Figure 14: Arrangement of the disaster relief containers on the deck of the heavy lift ship



The arrangement of the different disaster relief facilities on the deck of the heavy lift ship is designed to provide a flow between facilities that are related to one another. For example, the dining and shower facilities are located near the housing facilities to provide easy access from one area to the other. Also, all of the basic utility services such as solid and water waste treatment are located in an area adjacent to the housing and dining areas so that a complex system is not needed to route all of the waste to these areas.

## **Conclusions**

The purpose of this report is to summarize concepts generated by CISD personnel involving the use of commercially chartered heavy lift ships as platforms for conducting auxiliary military operations. These concepts show that through the use of modular systems, such as ISO containers and MCS sections, a commercially chartered heavy lift ship can be configured for several different missions. These modules can be pre-positioned in strategic locations to provide fast response when a disaster or emergency situation arises. As a result, the US Navy can combine different modules together with a heavy lift ship and essentially build a ship for different situations when they arise, as opposed to permanently building a specific ship dedicated to each function from the outset. For example, in case of disasters such as hurricanes, supplies can be preloaded onto a heavy lift ship, which will wait just outside of affected area. Once hurricane is over, ship can move into place immediately to begin providing disaster relief.

The effectiveness of each of these concepts depends on the type of heavy lift ship that is available for charter and the modularity of the auxiliary systems. The modular systems built to handle certain situations have to be able to work with a variety of different heavy lift ships because in the case of an emergency, the ideal heavy lift ship may not be available. As a result, the modular systems must be able to work with whatever heavy lift ship is available at the time of need.

Each type of heavy lift ship offers different advantages disadvantages compared to the others when being employed as a platform for staging naval auxiliary operations. There is a tradeoff between the advantages offered by the different heavy lift ships for each type of mission. For example, MCRS concept can support the most people when utilizing a large, open deck heavy lift ship such as the MV Black Marlin. However, the open deck of the MV Black Marlin provides little protection from the environment in comparison to a wind walled heavy lift ship such as the MV Explorer. The decision of which type of heavy lift ship to use will ultimately depend on the specific mission at hand as well as the availability of heavy lift ships at the time one is required.

Overall, the use of a commercially chartered heavy lift ship as a platform for conducting auxiliary naval operations would allow the US Navy to conduct several different types of missions without building dedicated ships for each mission. The modularity of the design of each system allows use with a variety of different heavy lift ships; each ship providing different advantages and disadvantages depending on the operation at hand. One disadvantage of this concept is that operation may be limited by the sea state. The sea keeping characteristics of each concept is not considered in this report but should be considered in the future.

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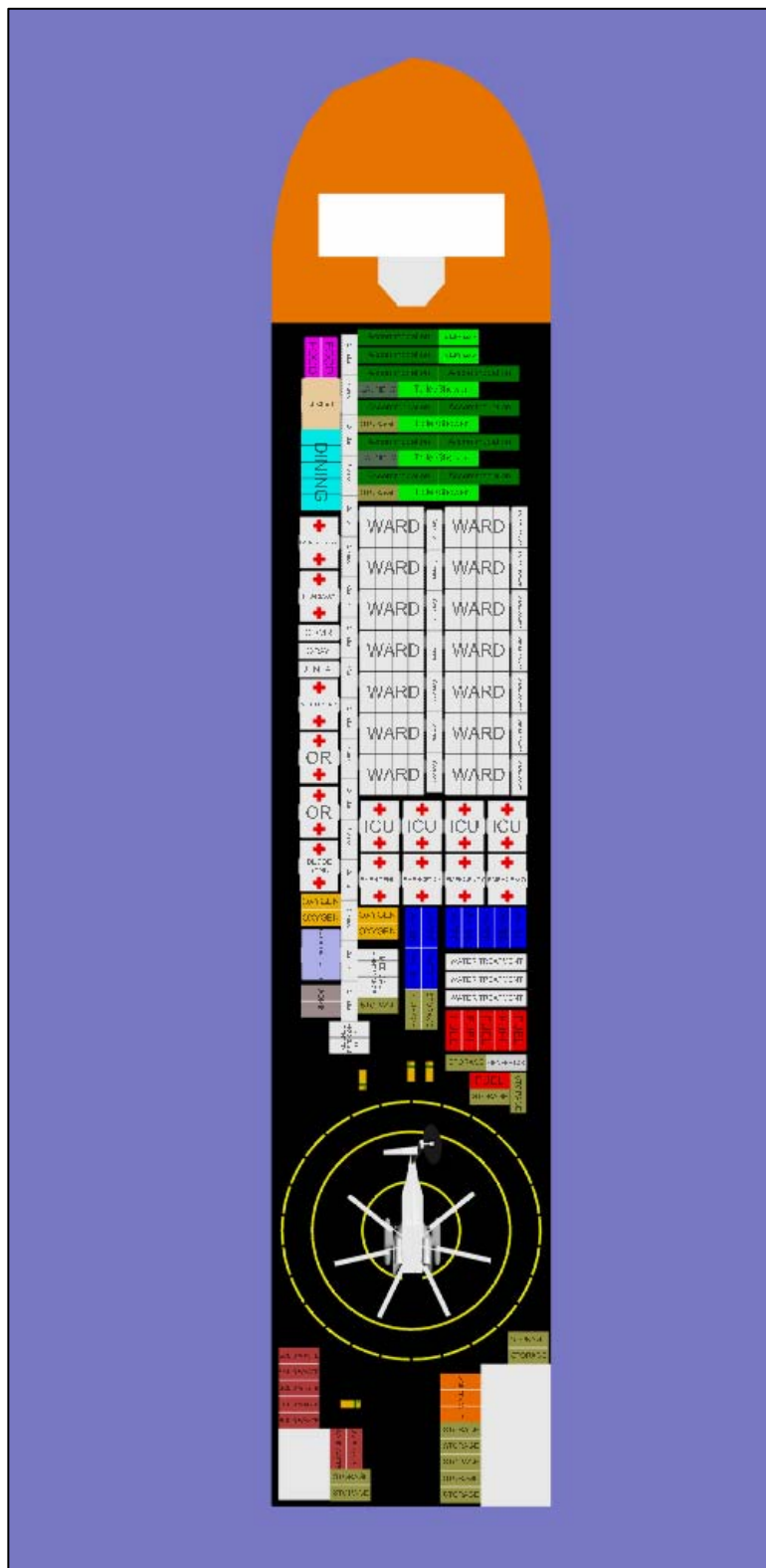
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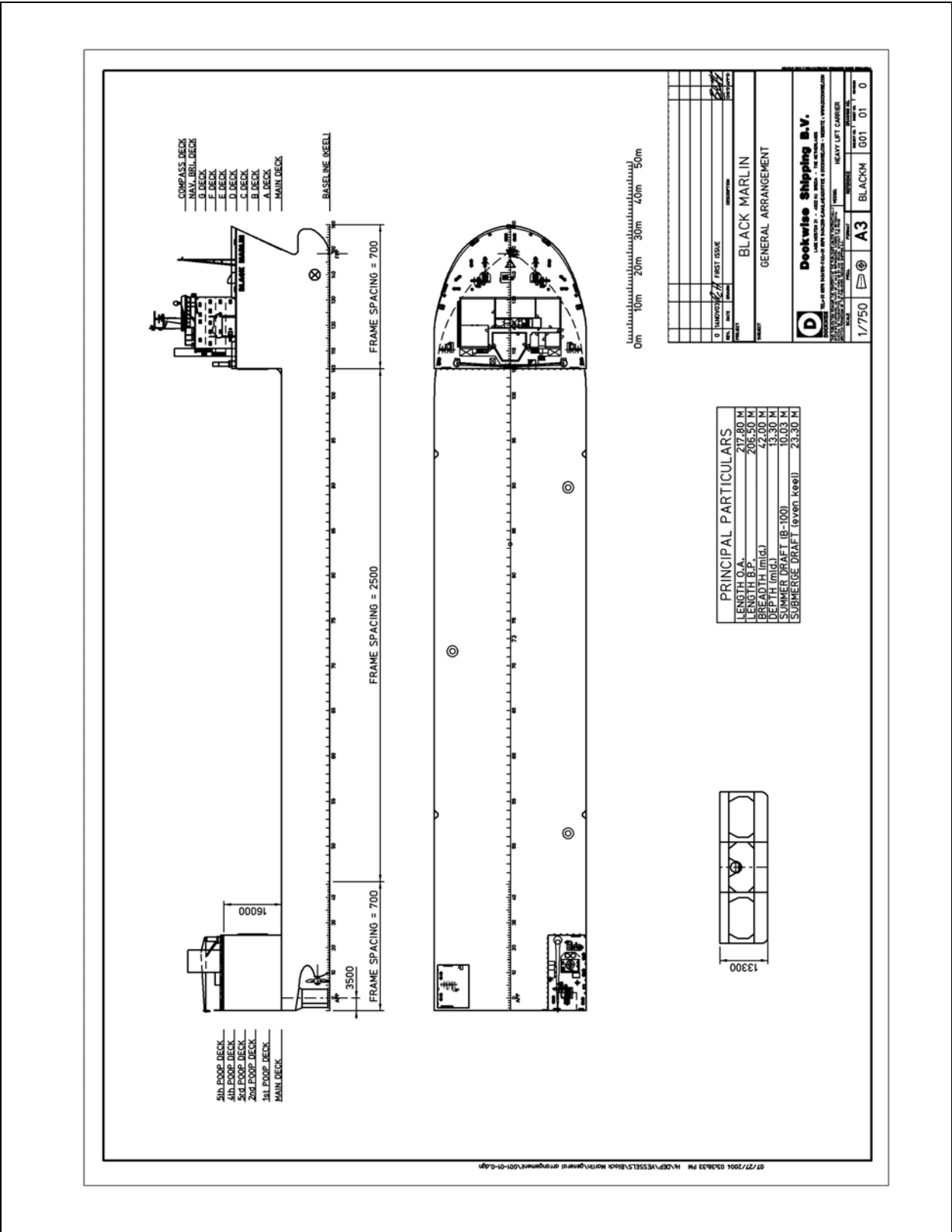
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## Appendix A Top View of MCRS on M.V. Black Marlin



Appendix B M. V. Black Marlin



## Appendix C M. V. Swan

